UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

# CALIBRATION OF A 10-INCH JET FLOW GATE

## Report No. HYD-569

HYDRAULICS BRANCH
DIVISION OF RESEARCH

OFFICE OF CHIEF ENGINEER
DENVER, COLORADO

FEBRUARY 1969

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Where approximate or nominal English units are used to express a value or range of values, the converted metric units in parentheses are also approximate or nominal. Where precise English units are used, the converted metric units are expressed as equally significant values. A table of conversion factors--BRITISH TO METRIC UNITS OF MEASUREMENT--is provided at the end of this report.

Report No. HYD-569

# CALIBRATION OF A 10-INCH JET FLOW GATE

by

D. Colgate

February 1969

DIVISION OF RESEARCH
HYDRAULICS BRANCH

UNITED STATES DEPARTMENT OF THE INTERIOR • BUREAU OF RECLAMATION
Office of Chief Engineer . Denver, Colorado

The valve calibration and evaluation was conducted by the author. The studies and report were reviewed by the Structures and Equipment Head, Mr. William E. Wagner, under the direction of the Hydraulics Branch Chief, Mr. Harold M. Martin. The results of the study were reviewed by the Mechanical Branch, Division of Design.

CONTENTS

## ABSTRACT

A simplified jet-flow regulating gate was developed by the Bureau of Reclamation for installation in small conduits of high head outlet works. The gate consists of an orifice to produce a contracting jet that springs clear of the gate slots, a movable gate leaf, a hydraulic cylinder and pump for moving the gate leaf, and an aerated downstream conduit. The regulating gate is simple to construct, cavitation-free at any gate opening, and the oil cylinder actuating mechanism is manually operated. One 10-in. (25.4-cm) regulating gate (10-in. orifice), designed for 250 ft (76.2 m) of head, was laboratory tested prior to being installed in a 12-in. (30.48-cm) bypass pipe in the outlet works at East Canyon Dam, Utah. Details of valve construction, operation, and coefficients of discharge and head loss are shown in the report. The maximum oil cylinder pressure required for gate movement is 185 psi (13.0 kg/sq cm) for a 250-ft (76.2-m) reservoir head. The discharge coefficient for the fully opened gate is 0.793, based on the area of the orifice and the total head in the pipeline (1.7 orifice diameters upstream from the orifice). The gate is excellent for control and discharge determination.



DESCRIPTORS--/ gates/ *high pressure gates/ slide gates/ jets/ hydraulic structures/ outlet works/ *small structures/ control structures/ *manual control/ *discharge coefficients/ *flow control/ laboratory tests/ Utah/ hydraulic equipment/ calibrations/ gate position indicators/ head loss
IDENTIFIERS--/ East Canyon Dam, Utah/ Weber Basin Project, Utah/ jet-flow gates

# CALIBRATION OF A 10-INCH JET-FLOW GATE

## PURPOSE

The purpose of this laboratory study was to determine the operational characteristics of, and to calibrate, a standardized 10-inch jet-flow gate to be installed at East Canyon Dam, Utah.

## CONCLUSIONS

1. The gate operates smoothly in all gate leaf positions and under all combinations of head and discharge available in the laboratory.

2. The coefficient of discharge of the fully opened gate is 0.793 based on the area of the orifice and the total head 1.7 orifice diameters upstream from the orifice (Figure 12).

## RECOMMENDATIONS

1. Install a hook or spring clamp to hold the hand-pump operating handle in the full forward stroke position when the pump is not in use (Figure 9A).

2. Refine the point of the pointer and extend it over the indicator name plate to enable the operator to make precise gate position readings.

## INTRODUCTION

The jet-flow gate, developed by the Bureau of Reclamation, is a relatively inexpensive regulating device for high head outlet works. The gate consists of a movable gate leaf within a body having an orifice at the upstream side of the slot, and any desired shape of conduit downstream which will provide adequate aeration for the jet. The upstream face of the gate leaf is smooth and remains in contact with a seal contained in the orifice side of the gate body. Sealing at the upstream face eliminates the hydraulic downpull inherent in high head gates with downstream seals.

The contraction of the jet caused by the orifice prevents the jet from entering the gate slot, thereby eliminating the danger of cavitation downstream from the slots.

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1/Footnotes refer to references on page 8.

The gate is simply constructed, is capable of trouble-free operation at any gate opening, and the fully opened gate has a discharge coefficient of about 0.79 based on the total head in the approach conduit and the area of the orifice.

Three configurations of the upstream gate body are shown in Figure 1. One configuration, as at Shasta Dam for example,1/ includes an expanding section formed by a simple curved surface that is tangent to the upstream conduit wall and intersects the 45° orifice cone as shown in Figure 1A. This shape is relatively expensive because of the difficult fabrication of the curved expanding section.

Another configuration, as at Trinity Dam2/, includes a conical expanding section as shown in Figure 1B. This shape is less expensive than the shape used at Shasta Dam and possesses almost identical flow characteristics and discharge coefficients.

A new design for small jet-flow gates3/ consisting of an orifice installed in a conduit without an expanding upstream section, is shown in Figure 1C. Such a design includes many of the beneficial flow characteristics of the above gates having more sophisticated entrance shapes, and is relatively inexpensive to construct.

One of the new standardized jet-flow gates with a 10-inch-diameter orifice was fabricated for use in a 12-inch bypass conduit at East Canyon Dam, Utah. There was sufficient time between fabrication of the regulating gate and required delivery at the jobsite to permit a laboratory calibration and an operational evaluation of the gate. The results of the laboratory study appear in this report.

The equivalent metric units for the British units used in this report are tabulated in Chart I.

## CONSTRUCTION DETAILS

The 10-inch jet-flow gate was designed for use in 12-inch-diameter conduits with heads up to 250 feet. The nominal size of the gate is the orifice diameter. The basic design has also been used for larger jet-flow gates.

### Installation

In the installation at East Canyon Dam, the 10-inch jet-flow gate will be used to control small discharges through a 12-inch bypass pipe around the high-pressure slide gate in the outlet works (Figure 2). The maximum head on the system will be 175 feet. Installation dimensions and details, gate support, and 16-inch-diameter exit pipe details are shown in Figures 2 and 3.

## Gate Bodies

Corrosion-resisting materials are used on all parts of the gate in contact with water to avoid corrosion and to minimize maintenance. The upstream gate body includes a standard 125-pound, 12-inch pipe flange and a short 12-inch-diameter entrance section (Figures 4 and 8A). The downstream end of the upstream body is recessed and drilled to receive the orifice and seal ring.

The downstream body includes the gate slots, a short 14-inch-diameter section immediately downstream from the gate leaf, and a flange, for this specific installation, to accommodate a 16-inch-diameter downstream adapter tube (Figures 4 and 8B).

## Gate Leaf and Seal Ring

The gate leaf is solid, 13-7/8 inches wide, 11-1/2 inches high, 1-9/32 inches thick, finishes on all surfaces and shaped on the bottom to allow the jet to spring free from the leading edge of the leaf during discharges at partial gate openings (Figure 5, Detail A, and Figure 8, A and B). The seal ring is so designed that the upstream face of the gate leaf is continually in contact with it, forming an upstream seal. The upstream face of the seal ring is chamfered 45° and extends inward from the 12-inch-diameter entrance of the upstream gate body to form the 10-inch-diameter orifice as shown in Detail E, Figure 5. This orifice produces the "jet" from which the jet-flow gate derives its name.

Details of the hydraulic actuating cylinder and the gate leaf position indicator are shown in Figure 5.

## Gate Assembly and Servicing

The gate assembly, including the actuating cylinder and gate leaf position indicator, tolerances, clearances, overall dimensions, and position limits of moving parts is shown in Figure 6. Operating and servicing instructions, together with a schematic diagram of the hydraulic actuating mechanism, are shown in Figure 7.

# LABORATORY INSTALLATION

## Gate Mounting

The 10-inch jet-flow gate was mounted in the laboratory at the end of a 43-foot length of straight, horizontal 12-inch standard pipe (Figure 9A). The 16-inch-diameter outlet adapter mounted on the downstream body flange passed through the wall of a plywood splash box from which the water returned to the laboratory reservoir.

## Piezometers

Four 1/8-inch-diameter piezometer taps were located in the approach pipe on the quarter points 12 inches upstream from the upstream valve body flange, (17 inches from the orifice) and were manifolded into a single lead (Figures 9A and B). The conduit pressures were measured on a single-leg water-filled manometer for heads up to 12 feet, and with mercury for heads greater than 12 feet. An additional piezometer was located in the top of the 16-inch downstream adapter 1-inch downstream from the flange. Pressures from this tap were measured on a water-filled "U" tube (Figure 9B).

## Laboratory Supply

Water for the valve was pumped from the laboratory reservoir through any one of four calibrated venturi meters. The maximum laboratory discharge was 13.6 cfs and the maximum shut off head was 152 feet. Discharges could be accurately measured between 0.40 and 13.60 cfs.

## Leaf Position Indicator and Pointer

The indicator (Figure 5) when mounted at the highest possible position on the vertical adjusting slots, was too low to reach the lowest possible mounting position of the pointer. Our laboratory shops extended the slotted holes for vertical adjustment, and the indicator was properly installed so the indicated reading corresponded exactly with the gate leaf position. In this location, however, the indicator was not rigid, and care was exercised during testing to prevent it from being pushed out of position (Figure 9D). The pointer was so short and blunt that precise gate leaf position readings were difficult to make. A small white cardboard straightedge was held against the indicator face to act as a pointer extension to assure that accurate gate leaf positions were set and maintained (Figure 10A). A longer, less blunt pointer should be furnished to enable the operator at the installation site to make accurate gate leaf position readings.

## Oil Pressure Indicator

For oil pressure measurements in the actuating system, a 100-psi Bourdon-type dial gage was installed in Tee 24-A by removing Plug 30A (Figure 2). The centerline of the horizontally mounted gage was 3-3/4 inches above the closing pressure inlet pipe (Figure 10B).

The oil tank was filled prior to being shipped to the laboratory, and oil was not added here. However, filling or draining the pump system as outlined in Figure 7, should be quite simple since all necessary plugs, vents, and valves are readily accessible (Figure 9D).

## LABORATORY TESTS

### Manual Operating System

The hand-pump operating handle and the selector valve lever were advantageously placed and readily accessible (Figures 8C and 9D). The gate leaf moved easily in either direction with light strokes of the operating handle for all situations tested, including the full shut-off head of the laboratory pumps on the gate leaf. The gate leaf remained in any preset position when the selector valve lever was placed midway between "open" and "close" (Neutral) even though the operating handle was repeatedly stroked and the discharge through the jet-flow gate was reduced from maximum to zero flow and returned to maximum. With the selector valve lever at the neutral position, the pump operating handle was pushed to the upward position nearest the oil reservoir as shown in Figure 9A. Within about 1 minute the handle dropped by its own weight to the extended position shown in Figure 9C. This is undesirable and it is suggested that a simple friction catch or manual hook be added to hold the lever in the upward position when it is not in use.

### Hydraulic Cylinder Oil Pressure

Oil pressure in the hydraulic cylinder above the piston was monitored for gate leaf movement from fully opened to fully closed with maximum head and discharge of the laboratory pumps on the system. The maximum oil pressure occurred during the gate leaf travel from "zero" to "closed" (1/2-inch overtravel). Measurements were recorded for the pressure in the cylinder while the gate leaf was moved in this critical region with various water pressures in the approach conduit. The test was limited by the 100-psi capacity of the pressure gage. A test run consisted of setting a head in the approach conduit with the gate leaf at "zero," moving the leaf in the closed direction by pushing the operating handle forward one full stroke in 1 second, and reading the gage pressure during the gate leaf movement. Results of the study are shown in Figure 10C. Extrapolation of the data (Figure 10C) shows that the oil pressure in the hydraulic cylinder will be about 134 psi with the East Canyon design head of 175 feet, and about 185 psi with the maximum head of 250 feet.

## Indicator and Pointer

Great care was exercised in properly positioning the indicator and pointer so that the bottom of the gate leaf was exactly tangent with the lowest point of the orifice when the pointer was at "0" on the indicator. At this setting some water will flow past the chamfer on the upstream face of the gate leaf (Figure 5, Detail A). The indicator measured exactly 10 inches between "0" and "10," and the orifice measured exactly 10 inches in diameter; therefore, the indicator presented an accurate reading of the gate leaf position.

## Operation and Calibration

Discharge calibration measurements were made for gate openings from 5 percent (1/2-inch open) to 100 percent (10 inches open), in increments of 5 percent. A check run at full open (1/2-inch overtravel) disclosed that the hydraulic conditions did not change as the gate leaf moved open beyond 100 percent. Tests were made for discharges and heads up to the maximum operating limits of the laboratory pumps (i.e., head = 152 feet, Q = 13.6 cfs) and down to 0.40 cfs, the minimum discharge which could be reliably measured in the laboratory 4-inch venturi meter.

The gate was watertight at openings from 1/4- to 1/2-inch overtravel in the closed direction. At very small openings the jet issuing from the gate was deflected downward and impinged on the 16-inch-diameter adapter, causing some splash and spray. However, aside from the drumming noise of the jet on the light metal, the operation was not objectionable. The jet was smooth at all gate openings above 2 or 3 percent. The maximum subatmospheric pressure measured on the top of the 16-inch adapter 1 inch downstream from the flange was 0.02 feet of water.

The head-discharge relationships for each gate opening, when plotted on a log-log chart, produced a straight line for all discharges and heads tested. The consistency of the data indicated that extrapolation or interpolation of the data would be permissible to determine the relationships existing at discharges, heads, and gate openings other than those tested. Figure 11 shows the discharge head relationships for the East Canyon Dam 10-inch jet-flow gate as installed in the laboratory.

Coefficients of discharge and head loss determinations for jet-flow gates geometrically similar to the one tested and with atmospheric pressure in the downstream conduit are shown in Figure 12. For installations with long downstream conduits, the head measured immediately downstream from the gate must be subtracted from the value of "h" in Figure 12. In all cases, the downstream conduit must be fully aerated.

Comments

The mechanical operation of the simplified jet-flow gate is excellent. The directional selector valve lever and hand-pump handle are easy to reach and operate. All plugs, vents, and valves on the oil reservoir are readily accessible. Flow from the jet-flow gate is smooth, and the discharge for a fixed gate leaf position and upstream head is constant and predictable. The simplified jet-flow gate is excellent for the intended use as a flow controller in small conduits and should provide long, trouble-free service.

## APPLICATION

The small jet-flow gate described herein is a cavitation-free control gate which may be used as an accurate metering device. The discharge coefficient curve, Figure 12, may be used for any geometrically similar jet-flow gate.

REFERENCES

1. The Hydraulic Design of a Control Gate for the 102-inch Outlets in Shasta Dam, Report No. Hyd-201.

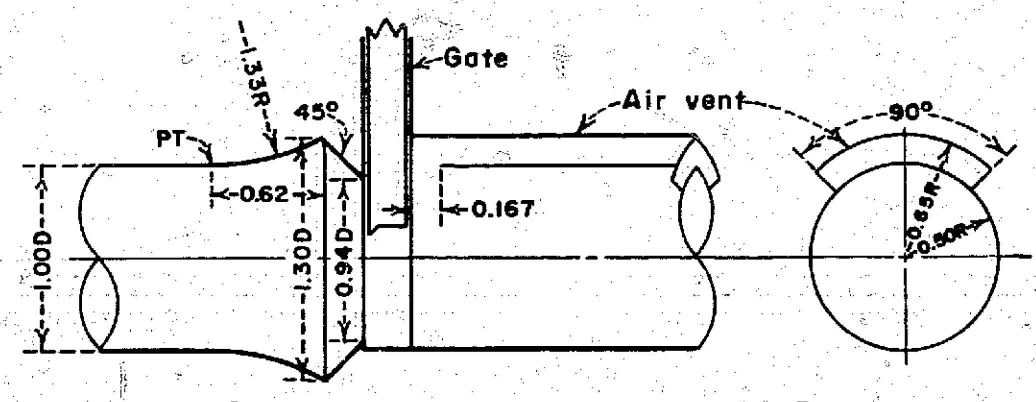
2. Hydraulic Model Studies of the Trinity Dam Auxiliary Outlet Works Jet-Flow Gate, Report No. Hyd-472.

3. Small Cavitation-Free Gate, Research Report No. Mech-3.

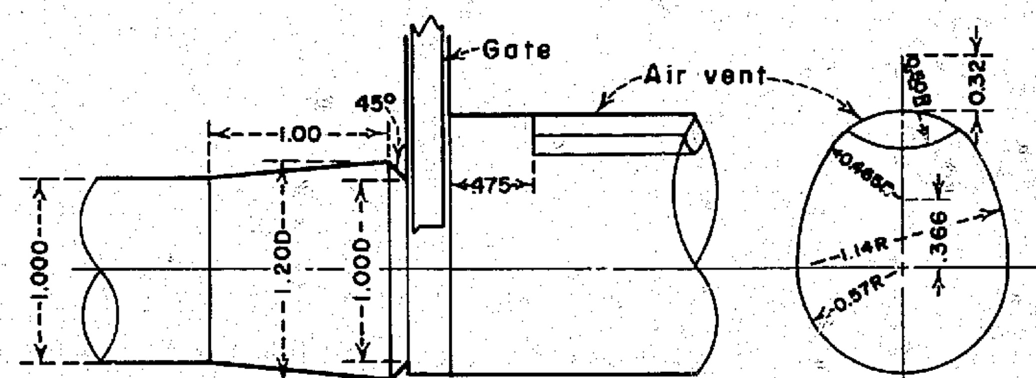
Chart I

Equivalent Metric Units for British Units used in this Report

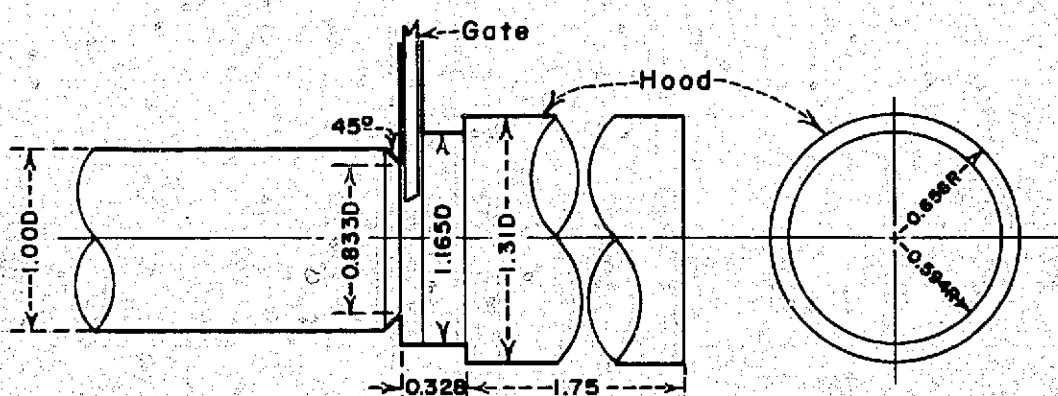
| Item | British Units | Metric Units |
|---|---|---|
| Orifice | 10-inch diameter | 25.4 cm |
| Conduit | 12-inch diameter | 30.48 cm |
| Exit hood | 16-inch diameter | 40.64 cm |
| Gate Leaf: | | |
| Width | 13-7/8 inches | 352.4 mm |
| Height | 11-1/2 inches | 292.1 mm |
| Thickness | 1-9/32 inches | 32.5 mm |
| Leaf overtravel | 1/2 inch | 12.70 mm |
| Piezometer taps | 1/8-inch diameter | 3.175 mm |
| Piezometer location | 17 inches US | 43.18 cm |
| Maximum design: | | |
| Head | 250 feet | 76.2 m |
| Q | 54.85 cfs | 1.55 cu m/sec |
| Oil pressure | 185 psi | 13.0 kg/cm$^2$ |
| Maximum lab head | 152 feet | 46.33 m |
| Maximum lab Q | 13.6 cfs | 0.385 cu m/sec |
| East Canyon location: | | |
| Maximum head | 175 feet | 53.34 m |
| Maximum Q | 45.89 cfs | 1.30 cu m/sec |
| Max oil pressure | 134 psi | 9.42 kg/cm$^2$ |




A. SHASTA DAM JET FLOW GATE




B. TRINITY DAM JET FLOW GATE



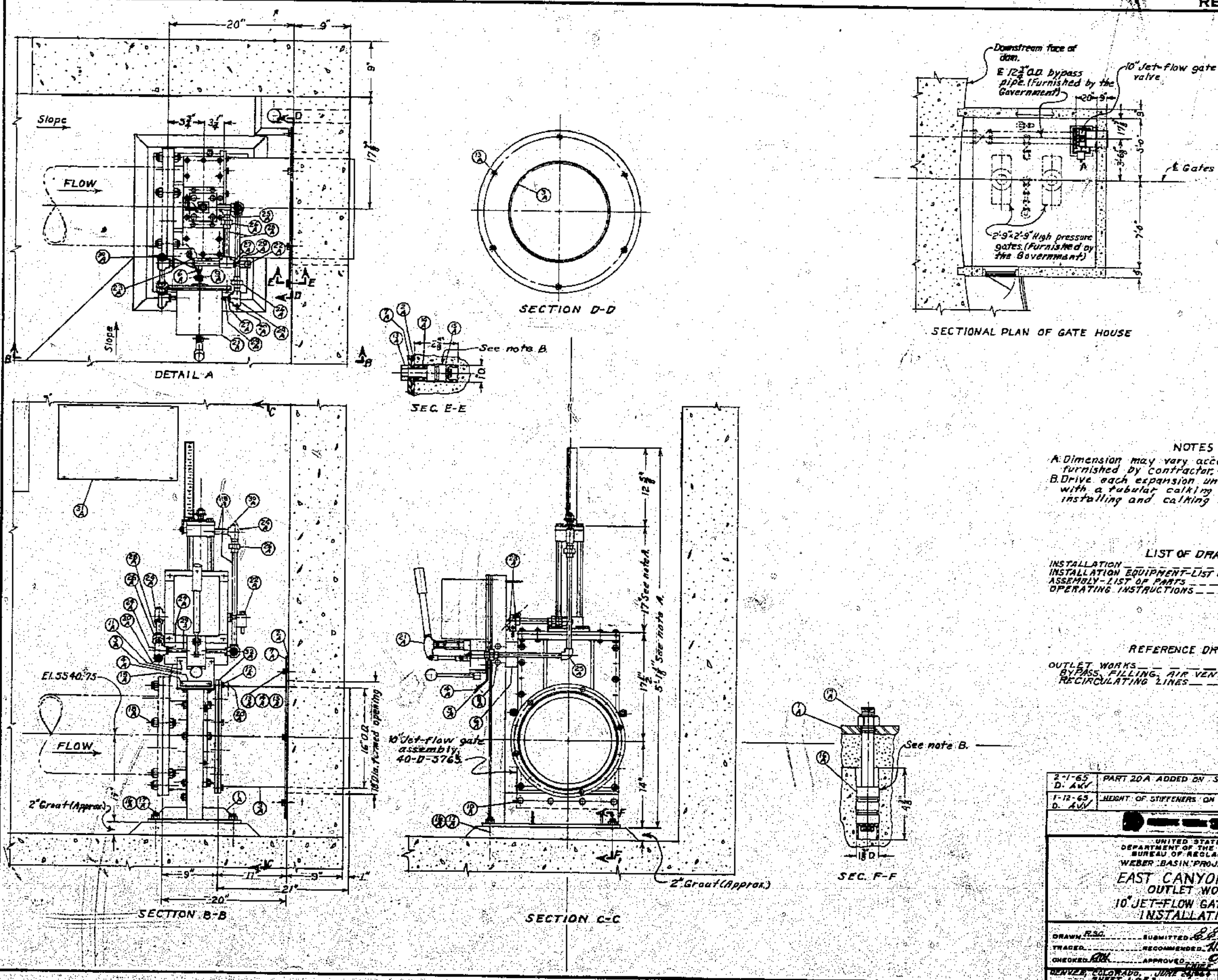

C. EAST CANYON DAM JET FLOW GATE

EAST CANYON DAM
OUTLET WORKS

10" JET – FLOW GATE
JET – FLOW GATE CONFIGURATIONS

716

FIGURE 2
REPORT HYD-569




NOTES

A. Dimension may vary according to equipment furnished by contractor. See specifications.
B. Drive each expansion unit to refusal with a tubular calking tool before installing and calking subsequent units.

LIST OF DRAWINGS

INSTALLATION ---------- 526-D-2925
INSTALLATION EQUIPMENT-LIST OF PARTS -- 526-D-2926
ASSEMBLY-LIST OF PARTS ---------- 40-D-5765
OPERATING INSTRUCTIONS ---------- 526-D-2927

REFERENCE DRAWINGS

OUTLET WORKS ---------- 526-D-2819
BYPASS, FILLING, AIR VENT AND RECIRCULATING LINES ---------- 526-D-2823

| | |
|---|---|
| 2-1-65 D. AKV | PART 20A ADDED ON SECTION B-B |
| 1-12-65 D. AKV | HEIGHT OF STIFFENERS ON PART 14 CHANGED. |

UNITED STATES
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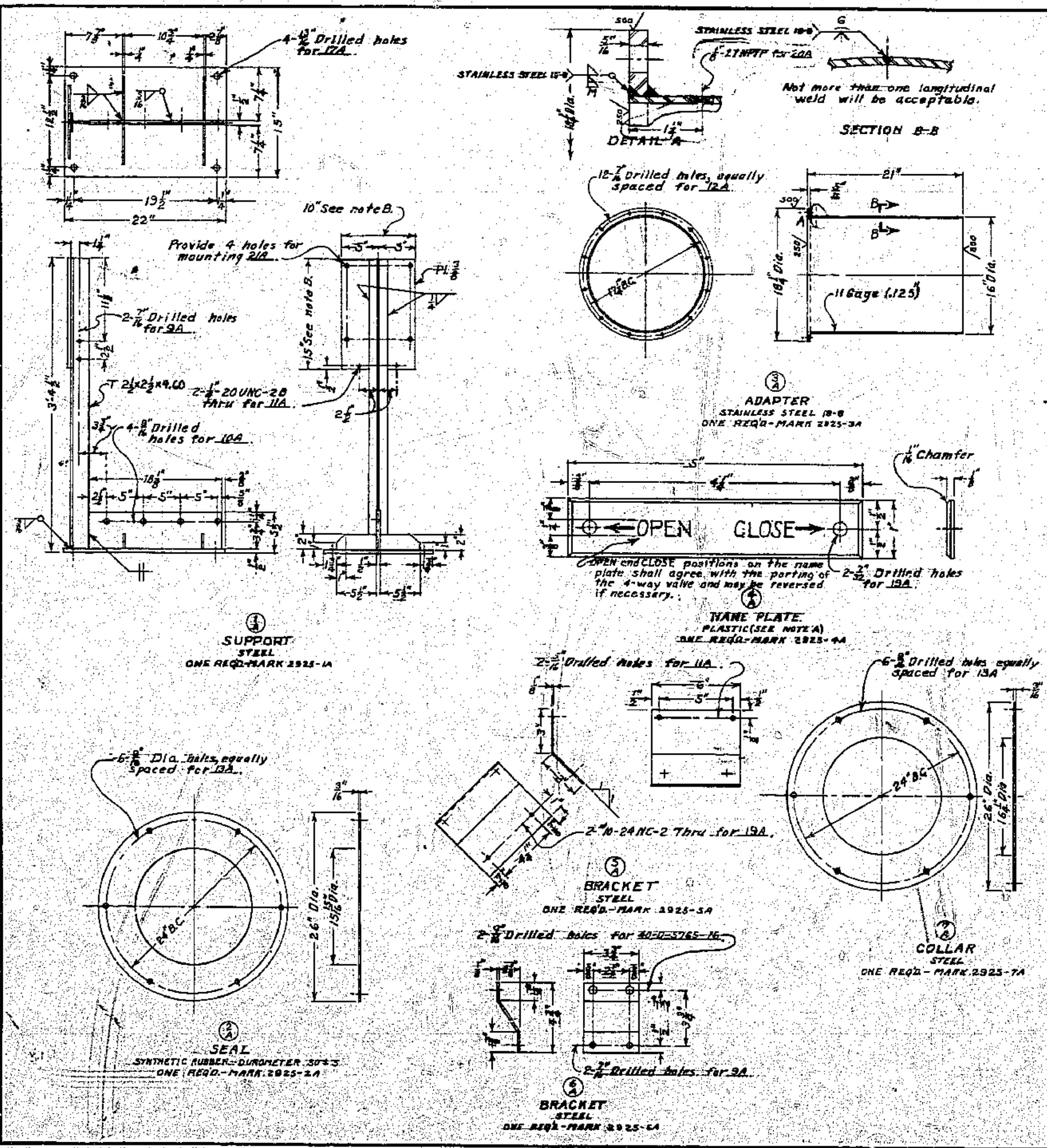
WEBER BASIN PROJECT—UTAH

EAST CANYON DAM
OUTLET WORKS
10" JET-FLOW GATE VALVE
INSTALLATION

DRAWN R.S.O. SUBMITTED E.E. Douglas
TRACED RECOMMENDED H.C. [illegible]
CHECKED [illegible] APPROVED [illegible] CHIEF DESIGNING ENGINEER
DENVER, COLORADO, JUNE 24, 1964 SHEET 1 OF 3 526-D-2925




LIST OF PARTS-INSTALLATION EQUIPMENT FOR ONE 10" JET-FLOW GATE VALVE

| DRAWING NUMBER | PART NO. | NO. REQ'D | DESCRIPTION | MATERIAL * |
|---|---|---|---|---|
| 40-D-5765 | 1 THRU 22 | ONE | 10" Jet flow gate valve assembly | |
| | | | | |
| 526-D-2926 | 1A | 1 | Support | Steel |
| " | 2A | 1 | Seal | Synthetic rubber-durometer 50±5 |
| " | 3A | 1 | Adapter | Stainless steel 18-8 |
| " | 4A | 1 | Name plate | Plastic |
| " | 5A | 1 | Bracket | Steel |
| " | 6A | 1 | Bracket | Steel |
| " | 7A | 1 | Collar | Steel |
| | 8A | | | |

UNDETAILED PARTS

| PART NO. | NO. REQ'D | DESCRIPTION | USED WITH PARTS | MATERIAL * |
|---|---|---|---|---|
| 9A | 2 | 3/8"-16UNC-2A x 2 1/4" Hex. hd. bolt and hex. nut | 1A, 6A | Steel |
| 10A | 4 | 1/2"-13UNC-2A x 2 1/2" Hex. hd. bolt and hex. nut | 40-D-5765-1, 3A AND 32A | Steel |
| 11A | 2 | 1/4"-20UNC-2A x 1/2" Hex. hd. cap screw | 1A, 5A | Steel |
| 12A | 12 | 3/8"-16UNC-2A x 1" Hex. hd. cap screw | 40-D-5765-2, 3A AND 32A | Stainless steel 18-8 |
| 13A | 6 | 1/2"-13UNC-2A x 2 1/2" Hex. hd. bolt | 2A, 7A, 14A, 15A | Steel |
| 14A | 8 in. | 1" O.D. x 1/8" Wall welded mech. tubing | 13A, 15A | Steel |
| 15A | 6 | 1/2"-13UNC-2A, 2 Unit expansion anchor | 13A, 14A | Steel and lead † |
| 16A | 4 | 3/4"-10UNC-2A, 3 Unit expansion anchor | 17A | Steel and lead † |
| 17A | 4 | 3/4"-10UNC-2A x 7 1/2" Stud with one nut, thread 1 1/2" each end | 16A | Steel |
| 18A | 12 | [illegible]UNC-2A x 3 1/2" Stud with two nuts, thread 1 1/2" each end | 40-D-5765-1 | Steel |
| 19A | 2 | #10-24NC-2 x 7/16" Round hd. mach. screw | 4A, 5A | Stainless steel |
| 20A | 1 | 1/8"-27NPTF pipe plug | 3A | Stainless steel |
| 21A | 1 | Hydraulic hand pump | 1A | See specs & note D |
| 22A | 1 | 1/4" Relief valve | | See specs & note D |
| 23A | 1 | 1/4" Globe valve, female | | Steel, see note D |
| 24A | 5 | 1/4" Tee, screwed | | Steel, see note D |
| 25A | 2 | 1/4" 90° Elbow, screwed | | Steel, see note D |
| 26A | 4 | 1/4" Union, male and female, ground joint, screwed | | Steel, see note D |
| 27A | 3 | 1/4" x 1/8" Hex. bushing | | Steel, see note D |
| 28A | 4.5 Ft. | 1/4" Black pipe, schedule 40 | | Steel, see note D |
| 29A | 14 in. | 1/8" Black pipe, schedule 40 | | Steel, see note D |
| 30A | 4 | 1/4" Square hd. pipe plug | | Steel, see note D |
| 31A | 1 | Mounting board, 19" wide x 12" high x 1/8" thick. | | Masonite, tempered grade, or equal. |
| 32A | 1 | Gasket, 1/8" thick to suit flange on adapter 3A | | Compressed asbestos |
| 33A | | | | |

* Contractor to furnish suitable, high-class, commercial materials.
† Expansion anchors shall conform with Federal Specification FF-S-325, Group I, Type I, Class 2. Proof load test not required.

NOTES

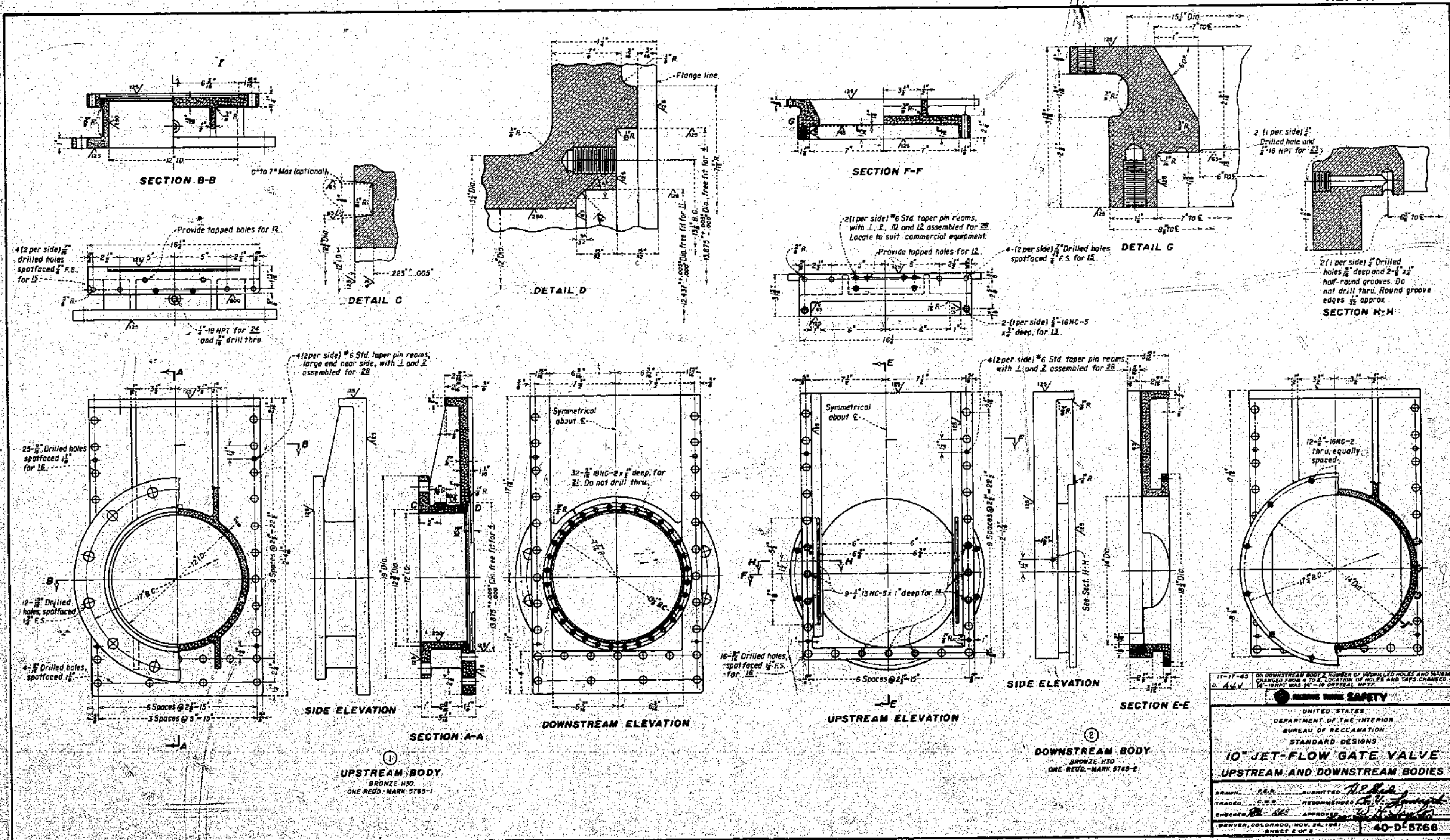
A. The name plate shall be made of laminated plastic with a white core and black surfaces conforming to Military Specification MIL-P-78A, type NBP. The lettering shall be done by machine, using standard lettering guides, and shall be cut thru to the white core.
B. If dimensional or other changes are required to suit commercial equipment, see specifications.
C. The mark numbers are to be placed on the parts according to the instructions in the specifications. Mark numbers for undetailed parts shall have the same prefix number as detailed parts, followed by the proper part number.
D. All pipe, pipe fittings, and other commercial equipment with pipe threads shall be furnished with ASA B2.2 Dryseal NPTF thread form, and shall have a working pressure rating of not less than 1500 psi.

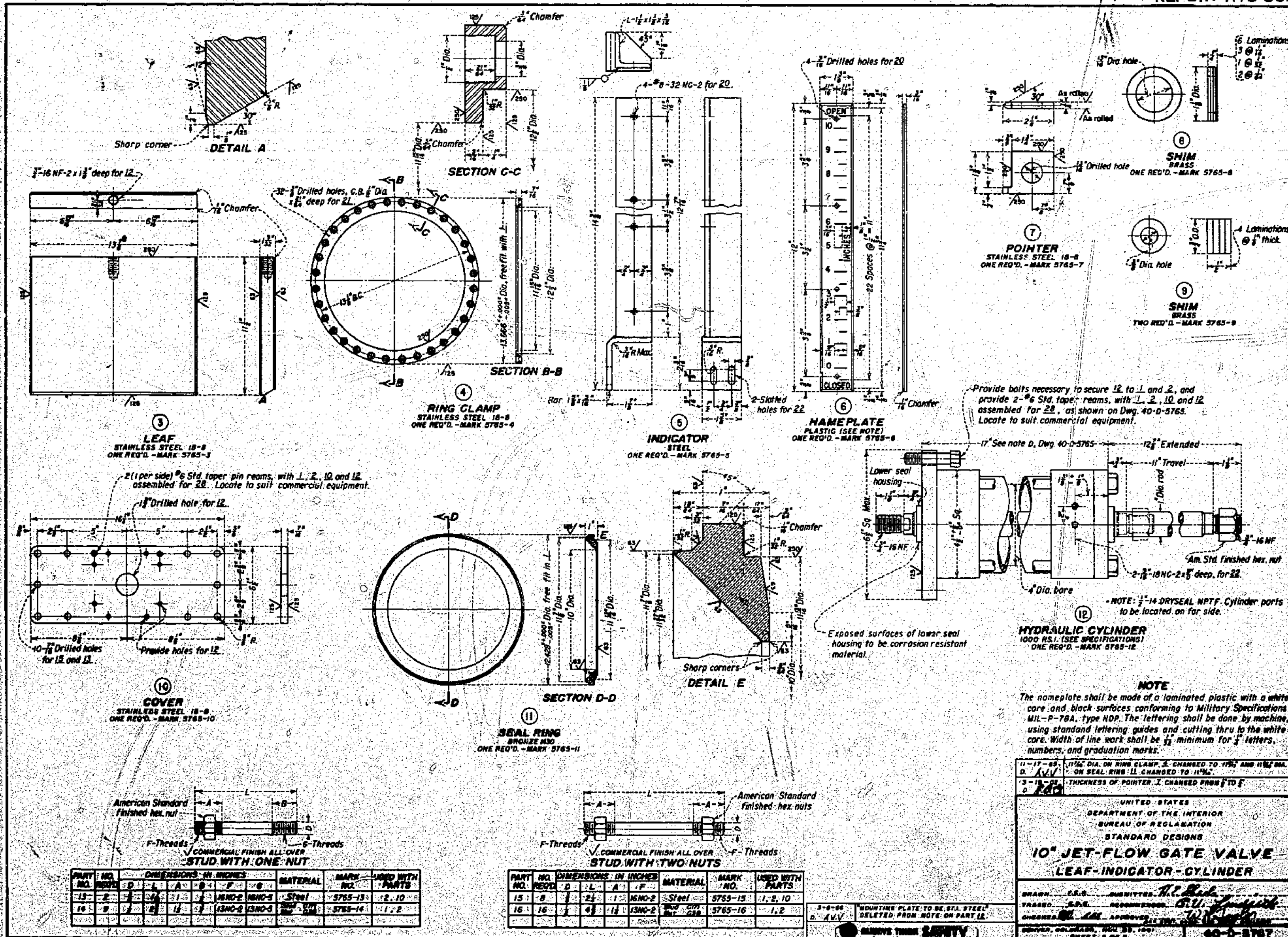
| | |
|---|---|
| 2-1-65 D. A.V.V. | 1/8"-27NPTF ADDED ON ADAPTER PART 3A, DETAIL A. PART 20A ADDED ON LIST OF PARTS. |
| 1-12-65 D. A.V.V. | HEIGHT OF STIFFENERS ON PART 1A CHANGED FROM 4" TO 2". |

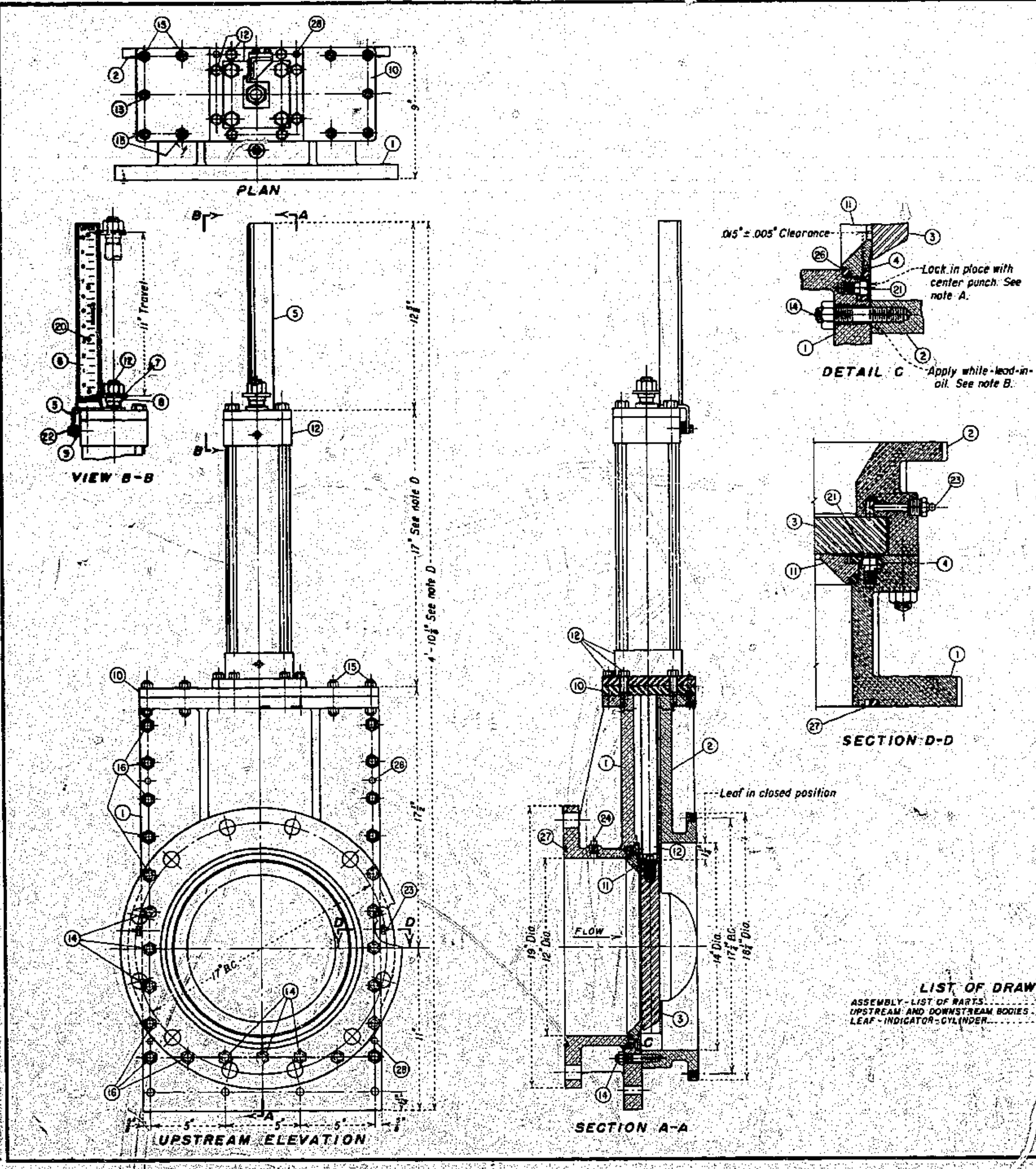
SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WEBER BASIN PROJECT-UTAH
EAST CANYON DAM
OUTLET WORKS
10" JET-FLOW GATE VALVE
INSTALLATION EQUIPMENT-LIST OF PARTS

DRAWN R.S.O. SUBMITTED E.O. [illegible]
TRACED RECOMMENDED [illegible]
CHECKED [illegible] APPROVED N.E. [illegible]
DENVER, COLORADO, JUNE 24, [illegible]
SHEET 2 OF 3
526-D-2926


SECTION B-B
DETAIL C
DETAIL D
SECTION F-F
DETAIL G
SECTION H-H
SIDE ELEVATION
SECTION A-A
DOWNSTREAM ELEVATION
UPSTREAM ELEVATION
SIDE ELEVATION
SECTION E-E
1 UPSTREAM BODY
BRONZE H30
ONE REQD.-MARK 5765-1
2 DOWNSTREAM BODY
BRONZE H30
ONE REQD.-MARK 5765-2
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
STANDARD DESIGNS
10" JET-FLOW GATE VALVE
UPSTREAM AND DOWNSTREAM BODIES
DENVER, COLORADO, NOV. 26, 1951
40-D-5766


DETAIL A
Sharp corner
SECTION C-C
SECTION B-B
LEAF
STAINLESS STEEL 18-8
ONE REQ'D. - MARK 5765-3
RING CLAMP
STAINLESS STEEL 18-8
ONE REQ'D. - MARK 5765-4
INDICATOR
STEEL
ONE REQ'D. - MARK 5765-5
NAMEPLATE
PLASTIC (SEE NOTE)
ONE REQ'D. - MARK 5765-6
POINTER
STAINLESS STEEL 18-8
ONE REQ'D. - MARK 5765-7
SHIM
BRASS
ONE REQ'D. - MARK 5765-8
SHIM
BRASS
TWO REQ'D. - MARK 5765-9
COVER
STAINLESS STEEL 18-8
ONE REQ'D. - MARK 5765-10
SEAL RING
BRONZE N30
ONE REQ'D. - MARK 5765-11
SECTION D-D
DETAIL E
Sharp corners
HYDRAULIC CYLINDER
1000 P.S.I. (SEE SPECIFICATIONS)
ONE REQ'D. - MARK 5765-12
Provide bolts necessary to secure 12 to 1 and 2, and provide 2-#6 Std. taper reams, with 1, 2, 10 and 12 assembled for 28, as shown on Dwg. 40-D-5765. Locate to suit commercial equipment.
Exposed surfaces of lower seal housing to be corrosion resistant material.
Lower seal housing
Am. Std. finished hex. nut
NOTE
The nameplate shall be made of a laminated plastic with a white core and black surfaces conforming to Military Specifications MIL-P-78A, type NDP. The lettering shall be done by machine, using standard lettering guides and cutting thru to the white core. Width of line work shall be 1/32 minimum for 1/8 letters, numbers, and graduation marks.
STUD WITH ONE NUT
STUD WITH TWO NUTS
COMMERCIAL FINISH ALL OVER
American Standard finished hex. nut
American Standard finished hex. nuts
MOUNTING PLATE TO BE STA. STEEL. DELETED FROM NOTE ON PART 12.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
STANDARD DESIGNS
10" JET-FLOW GATE VALVE
LEAF-INDICATOR-CYLINDER
40-D-5767




## LIST OF PARTS-ONE 10" JET-FLOW GATE VALVE

| DRAWING NUMBER | PART NO. | NO. REQ'D | DESCRIPTION | MATERIAL | MAT'L. REF. NO. |
|---|---|---|---|---|---|
| 40-D-5766 | 1 | 1 | Upstream body | Bronze | H30 |
| " | 2 | 1 | Downstream body | Bronze | H30 |
| 40-D-5767 | 3 | 1 | Leaf | Stainless steel 18-8 | * |
| " | 4 | 1 | Ring clamp | Stainless steel 18-8 | * |
| " | 5 | 1 | Indicator | Steel | * |
| " | 6 | 1 | Name plate | Plastic | * |
| " | 7 | 1 | Pointer | Stainless steel 18-8 | * |
| " | 8 | 1 | Shim | Brass | * |
| " | 9 | 2 | Shim | Brass | * |
| " | 10 | 1 | Cover | Stainless steel 18-8 | * |
| " | 11 | 1 | Seal ring | Bronze | H30 |
| " | 12 | 1 | Hydraulic cylinder | See specifications | * |
| " | 13 | 2 | Stud with one nut | Steel | * |
| " | 14 | 9 | Stud with one nut | Steel | Stud G171 Nut G38 |
| " | 15 | 8 | Stud with two nuts | Steel | * |
| " | 16 | 16 | Stud with two nuts | Steel | Stud G171 Nut G38 |

### UNDETAILED PARTS

| PART NO. | NO. REQ'D | DESCRIPTION | USED WITH PARTS | MATERIAL | MAT'L. REF. NO. |
|---|---|---|---|---|---|
| 20 | 4 | #8-32NC-2 x ¼" Fillister hd. mach. screw | 5,6 | Brass | * |
| 21 | 32 | $\frac{5}{16}$"-18NC-2 x ½" Socket hd. cap screw | 1,4 | Monel | * |
| 22 | 2 | $\frac{5}{16}$"-18NC-2 x 1" Hex. hd. cap screw | 5,12 | Stainless steel | * |
| 23 | 2 | ¼"-18NPT-Hydraulic fitting | 2 | Alemite 1627-B or equal | * |
| 24 | 1 | ¼"-18 NPT - Sq. hd. pipe plug | 1 | Brass | * |
| 25 | | | | | |
| 26 | 1 | 12" I.D. x 12½" O.D. x .275" ± .006" Dia. "O" ring gasket for use with water & grease | 1,11 | Synthetic rubber shore durometer hardness 35 to 65 | * |
| 27 | 1 | 13" I.D. x 13½" O.D. x .275" ± .006" Dia. "O" ring gasket for use with water | 1 | Rubber-shore durometer hardness 35 to 65 | * |
| 28 | 6 | #6 Std. taper pin, 0.341" dia. large end x 2" long | 1,2,10,12 | Steel 225-275 B.H.N. | * |

## MATERIALS-SPECIFICATIONS AND MINIMUM PHYSICAL PROPERTIES

| MAT'L. REF. NO. | MATERIAL | ULTIMATE TENSILE STRENGTH #/☐" | YIELD POINT TENSION #/☐" | % ELONG. IN 2" | % RED. IN AREA | SPECS. NUMBER | REMARKS |
|---|---|---|---|---|---|---|---|
| H30 | Cast phosphor bronze | 25,000 | 12,000 | 8 | — | S.A.E. No. 64 | — |
| G38 | Steel for nuts | — | — | — | — | ⓧA194-59T | Grade 2 |
| G171 | Alloy steel bolts, Quenched and tempered, 1⅛" Dia. and under. | 105,000 | 83,000 | 20 | 50 | ⓧA354-58T | Grade BB |

ⓧ A.S.T.M. Specifications

## NOTES

The mark numbers to be placed on the parts according to the instructions in the specifications. Mark numbers for undetailed parts shall have the same prefix number as detailed parts, followed by the proper part number.

* Contractor to furnish suitable high-class, commercial materials.

A. Lock all screws in seal ring at three points each with center-punch.

B. Apply white-lead-in-oil to mating surfaces of body flanges, cover, and cylinder mounting plate, before bolting parts together.

C. CAUTION: Do not apply white lead to mating surfaces of ring clamp and upstream body, and do not paint any of the interior surfaces of the gate valve assembly.

D. This dimension is nominal, and may vary according to equipment furnished by contractor.

THIS GATE VALVE RATED AT 107 P.S.I. MAXIMUM WORKING PRESSURE

## LIST OF DRAWINGS

ASSEMBLY-LIST OF PARTS .......... 40-D-5765
UPSTREAM AND DOWNSTREAM BODIES .......... 40-D-5766
LEAF-INDICATOR-CYLINDER .......... 40-D-5767

| | |
|---|---|
| 11-17-65 D. AVV | CHANGED PART 23 FROM GIANT HEAD TO HYDRAULIC FITTING AND REVISED LOCATION OF FITTINGS. REVISED SEC. D-D, PARTS 4 AND 11. DELETED PART 20 AND DRYSEAL THREAD REQUIREMENTS. |

ALWAYS THINK SAFETY

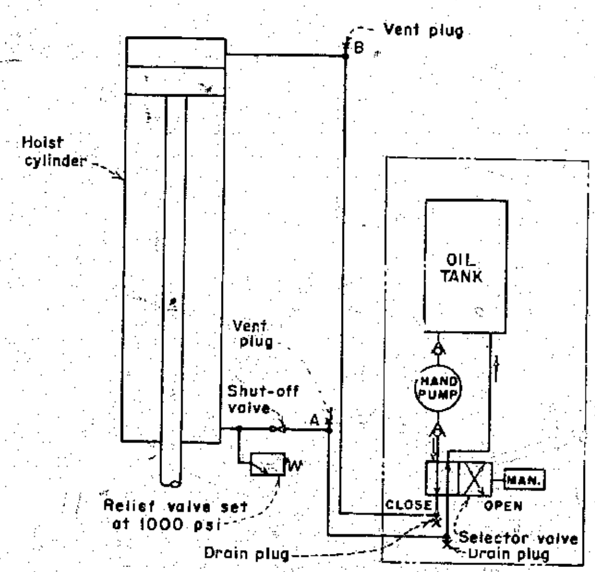
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
STANDARD DESIGNS

**10" JET-FLOW GATE VALVE**
**ASSEMBLY-LIST OF PARTS**

DRAWN AVV-FWF SUBMITTED H.E. Shele
TRACED F.F.M. RECOMMENDED C. J. Lundgreth
CHECKED RH. ALS APPROVED W. H. Taylor
DENVER, COLORADO, NOV. 28, 1961 SHEET 1 OF 3

40-D-5765

FIGURE 7
REPORT HYD-569




SCHEMATIC HYDRAULIC DIAGRAM

## OPERATING INSTRUCTIONS

**A. TO OPEN**

1. Open shut-off valve.
2. Set selector valve at OPEN.
3. Operate hand pump.
4. With gate at new opening, close shut-off valve.

**B. TO CLOSE**

1. Open shut-off valve.
2. Set selector valve at CLOSE.
3. Operate hand pump.
4. With gate at new opening, close shut-off valve.

## GENERAL INFORMATION

**C. DESIGN**

1. The jet-flow gate is designed for 107 psi water pressure.
2. The jet-flow gate is designed to regulate the discharge of water from the bypass pipe.
3. The oil hydraulic system is designed for a maximum operating pressure of 1000 psi and for a normal operating pressure of 650 psi.

**D. OPERATING INFORMATION**

1. The jet-flow gate is mounted on the discharge end of the bypass pipe. A 12" gate valve is installed in the bypass pipe just upstream from the jet-flow gate.
2. The jet-flow gate is for:
   Regulation of discharge from the outlet works.
3. The gate valve is for:
   a. Emergency closure if the jet-flow gate is inoperable.
   b. Shut-off when the jet-flow gate is not in use.
4. The jet-flow gate shall normally be closed when opening or closing the gate valve.
5. When the bypass is out of service and the gate valve is closed, the jet-flow gate should be opened to allow the pipe to drain.

## SERVICING INSTRUCTIONS

**E. FILLING SYSTEM WITH OIL**

1. General: About 2 gallons of oil are required. Use a light, clean, hydraulic oil, rust and oxidation inhibited, and having a standard Saybolt Universal viscosity of 150 seconds at 100° F. Keep the oil absolutely clean and avoid getting foreign matter into the system. Filter the oil thru a 100 mesh screen.
2. Fill oil tank. (As system is filled, pour make up oil into tank).
3. Fill hoist cylinder and lines:
   a. Remove both vent plugs, open shut-off valve, and set selector valve at OPEN.
   b. Operate hand pump until air is vented from vent plug A. Replace vent plug.
   c. Open gate.
   d. Set selector valve at CLOSE and operate hand pump until air is vented from vent plug B. Replace vent plug.
   e. Close gate. Remove vent plug A and set selector valve at OPEN. Operate hand pump until air is vented. Replace plug.
   f. Open gate. Remove vent plug B and set selector valve at CLOSE. Operate hand pump until air is vented. Replace plug.
   g. Repeat steps e and f until all air is vented.

**F. LUBRICATING GATE LEAF**

1. With gate leaf closed, remove pipe plugs on side of valve body. Apply grease thru grease fittings until grease shows at pipe plug openings. Replace pipe plugs. Repeat procedure every six (6) months. Use a grease equal to Texaco "All Temp" or any grease that conforms with Specification MIL-G-10924B.

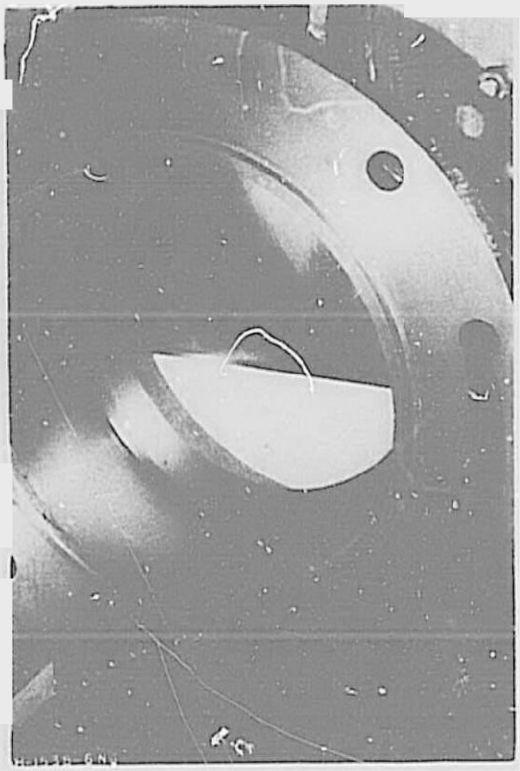
**NOTE**

Cement a plastic surfaced print of this drawing on mounting board 31A with Weldwood Super Contact Cement or equal. Place the mounting board on the gate house wall in the position shown on Section B-B, Drawing 526-D-2925.

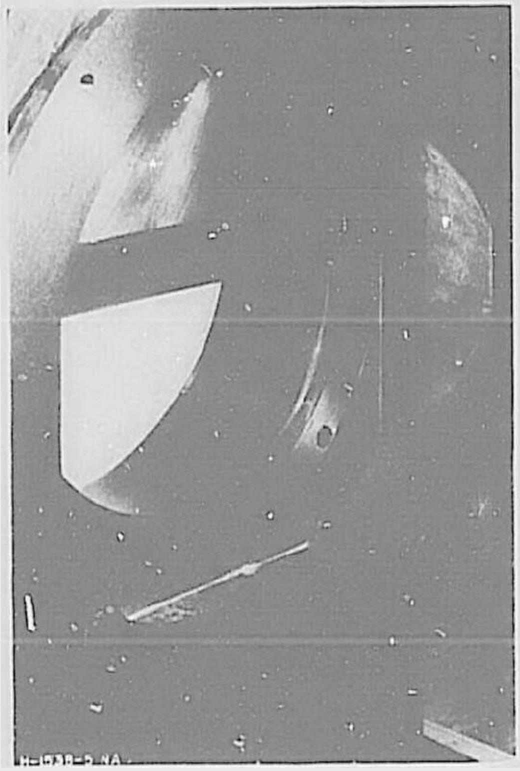
ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WEBER BASIN PROJECT-UTAH
EAST CANYON DAM
OUTLET WORKS
10" JET-FLOW GATE VALVE
OPERATING INSTRUCTIONS

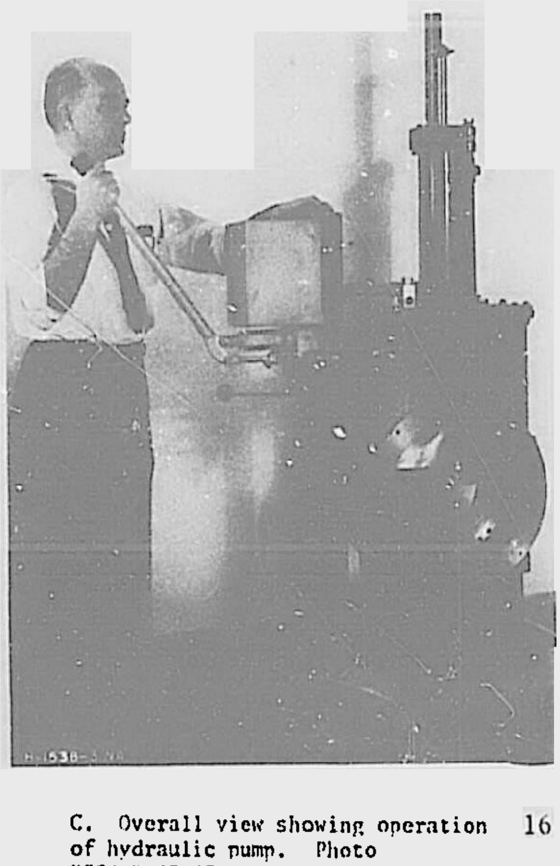
DRAWN A.V.V. SUBMITTED O.E. Gonzales
TRACED D.L.M. RECOMMENDED H.E. Snyder
CHECKED G.T.O. APPROVED [signature] CHIEF DESIGNING ENGINEER
DENVER, COLORADO, JUNE 24, 1964 SHEET 3 OF 3 526-D-2927



A. Upstream body and upstream face of gate leaf. Photo P526-D-63663



B. Downstream body and downstream face of gate leaf. Photo P526-D-63664

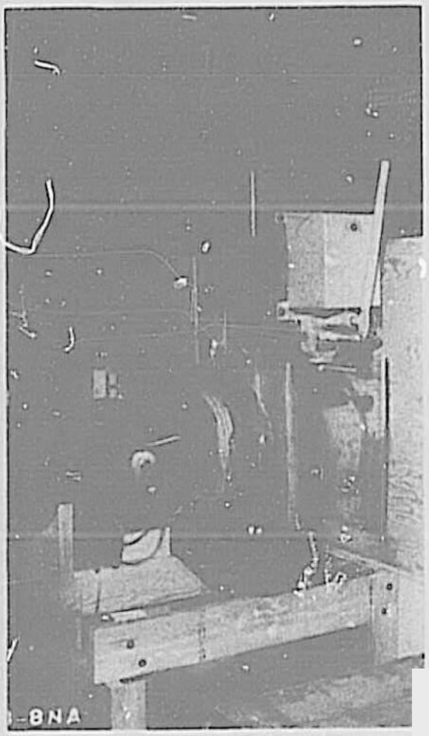


C. Overall view showing operation of hydraulic pump. Photo P526-D-63665

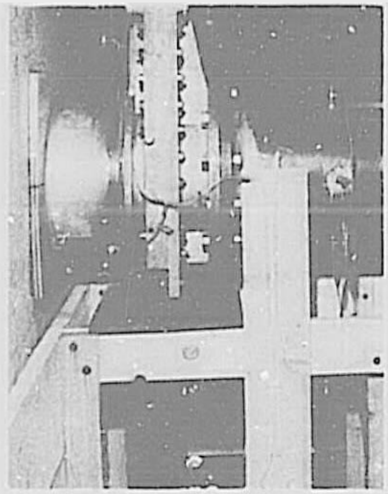
EAST CANYON DAM
OUTLET WORKS
10-INCH JET-FLOW GATE

Flow Passage Details
and Actuator Operation

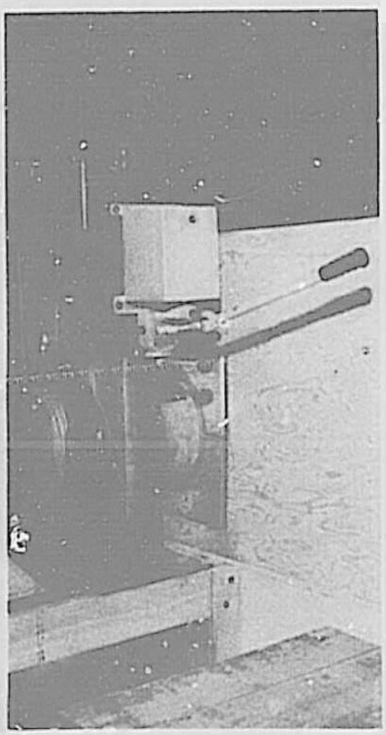
FIGURE 9
Report Hyd-569



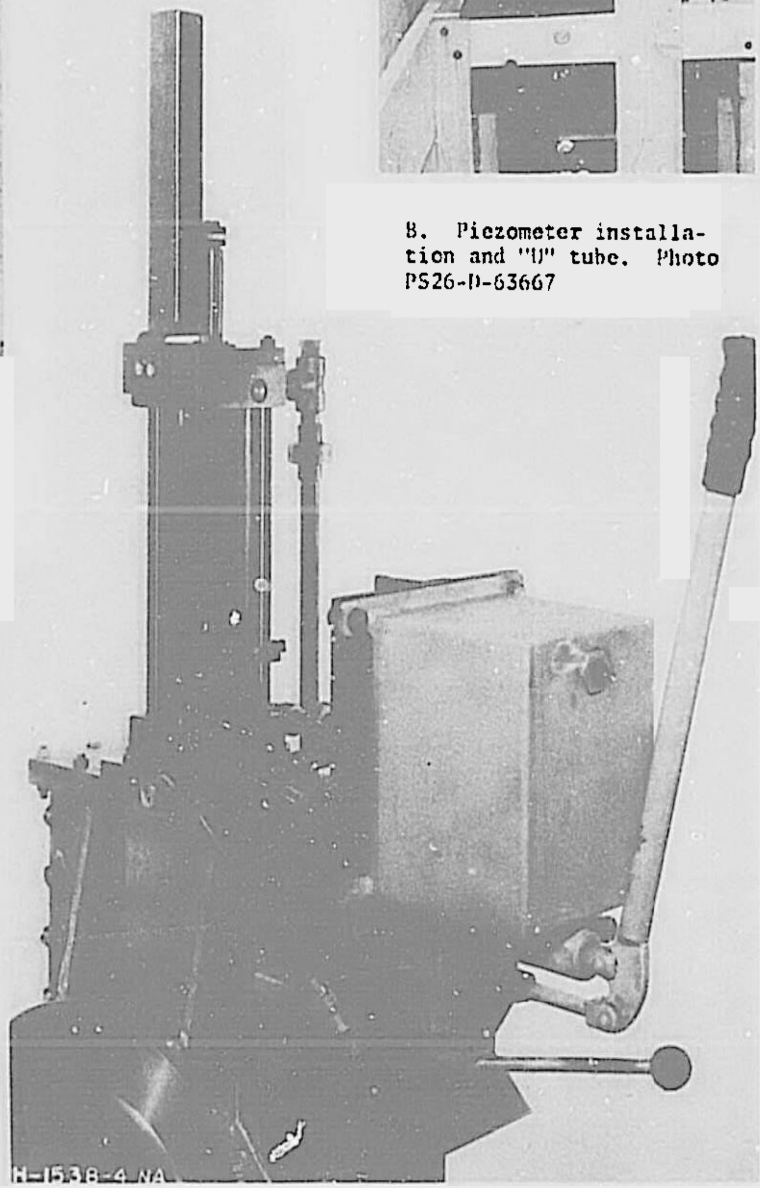
A. Laboratory installation - operating handle in upward position. Photo P526-D-53666



B. Piezometer installation and "U" tube. Photo P526-D-63667



C. Operating handle in extended position. Photo P526-D-63668

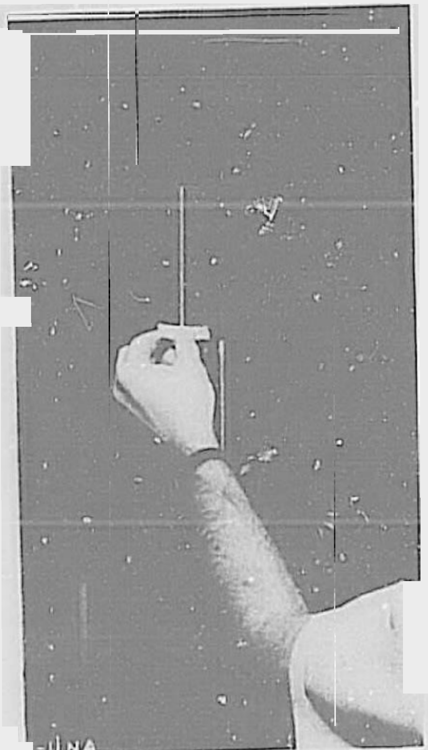



D. General view of actuating oil piping, cylinder, and leaf position indicator. Photo PX-D-63669

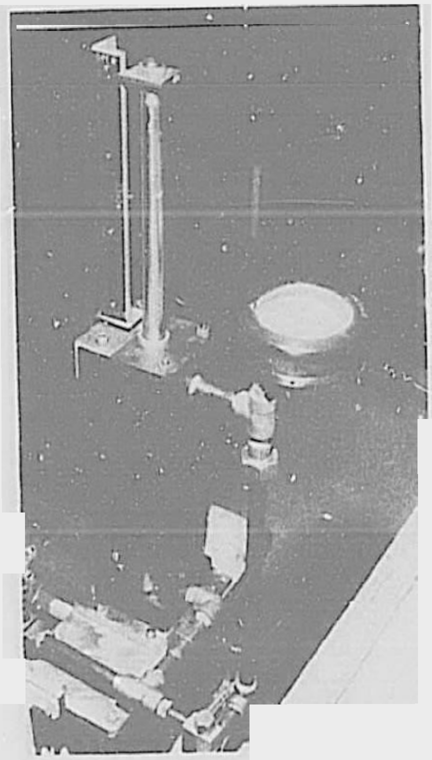
EAST CANYON DAM
OUTLET WORKS
10-INCH JET-FLOW GATE

Piping and Laboratory Installation

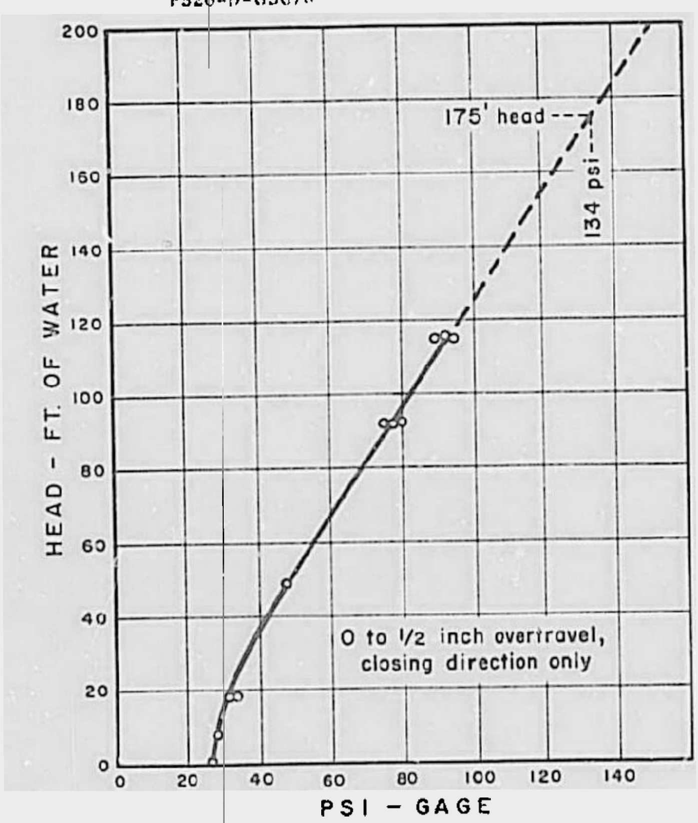
FIGURE 10
Report Hyd-569



A. Cardboard strip used as a pointer extension. Photo P526-D-63670



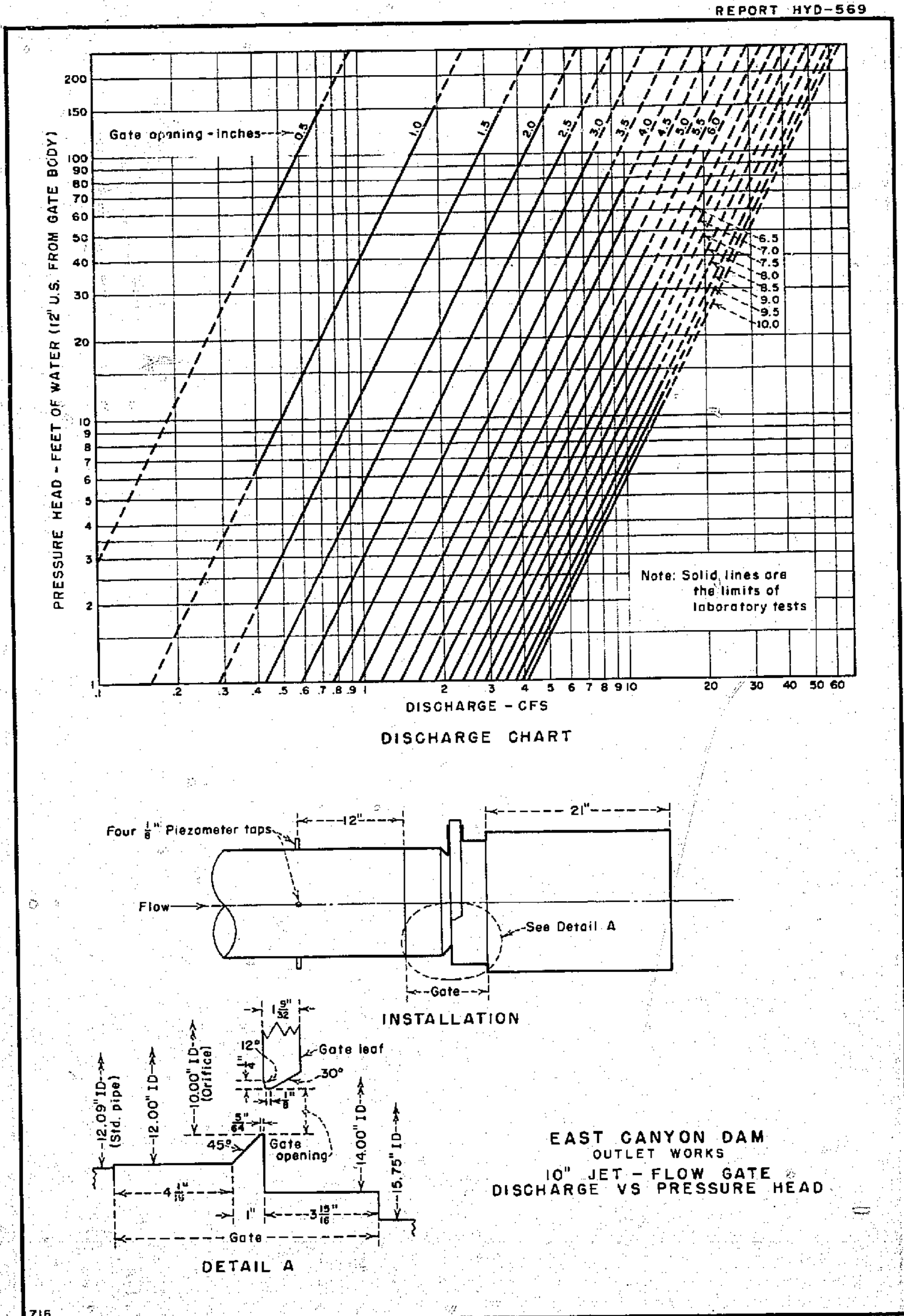
B. Oil pressure gage mounted for laboratory study. Photo P526-D-63671

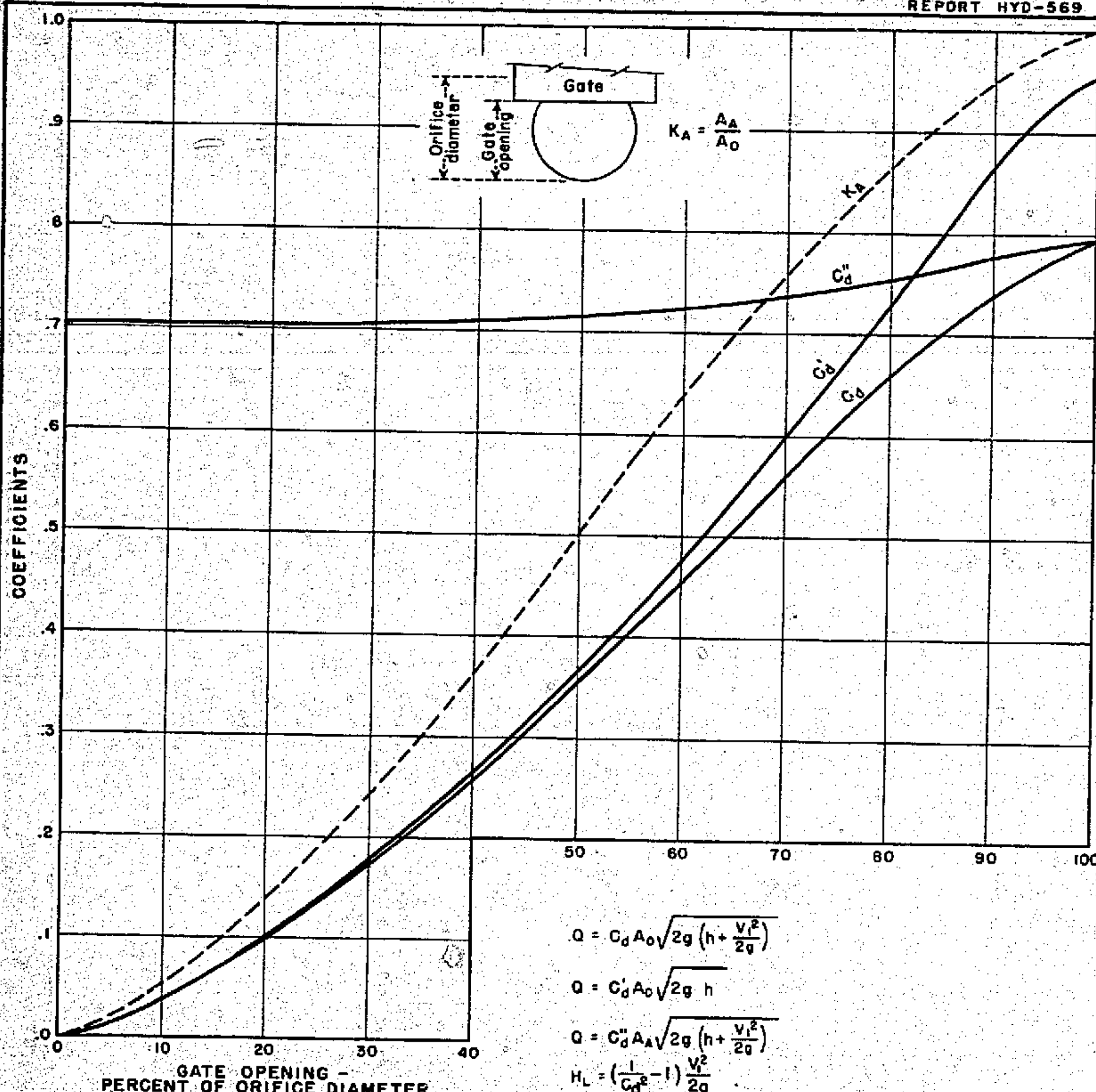



C. Approach conduit head versus actuating oil pressure, leaf travel from closed to 1/2-inch overtravel.

EAST CANYON DAM
OUTLET WORKS
10-INCH JET-FLOW GATE

Indicator, Details, Pressure Gage, and Actuating Oil Pressure Chart


PRESSURE HEAD - FEET OF WATER (12" U.S. FROM GATE BODY)
DISCHARGE - CFS
Gate opening - inches
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Note: Solid lines are the limits of laboratory tests
DISCHARGE CHART
Four 1/8" Piezometer taps
12"
21"
Flow
See Detail A
Gate
INSTALLATION
Gate leaf
30°
12°
12.09" ID (Std. pipe)
12.00" ID
10.00" ID (Orifice)
14.00" ID
15.75" ID
45°
Gate opening
Gate
DETAIL A
EAST CANYON DAM
OUTLET WORKS
10" JET - FLOW GATE
DISCHARGE VS PRESSURE HEAD
716



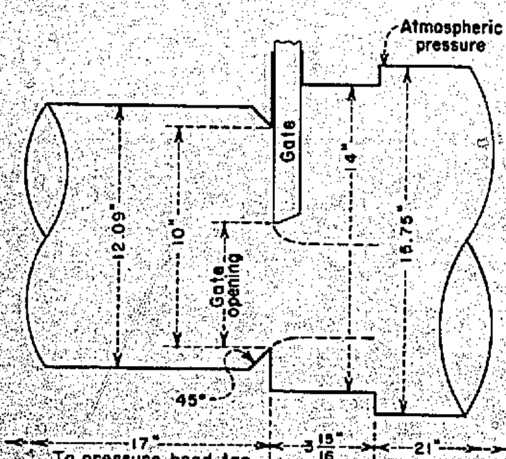

$$Q = C_d A_o \sqrt{2g\left(h + \frac{V_1^2}{2g}\right)}$$

$$Q = C_d' A_o \sqrt{2g\ h}$$

$$Q = C_d'' A_A \sqrt{2g\left(h + \frac{V_1^2}{2g}\right)}$$

$$H_L = \left(\frac{1}{C_d^2} - 1\right)\frac{V_1^2}{2g}$$

$A_O$ = 10" Orifice area (0.5454 sq. ft.)
$A_A$ = Open area under the gate
$h$ = Pressure head in 12" std. pipe 17" upstream from gate leaf - referenced to the pipe center line.
$V_1$ = Velocity in 12" pipe
$H_L$ = Head loss.




FLOW PASSAGE DETAILS

EAST CANYON DAM
OUTLET WORKS
10" JET - FLOW GATE
DISCHARGE AND HEAD LOSS COEFFICIENTS

716

7-1750
(2-67)
Bureau of Reclamation

# CONVERSION FACTORS--BRITISH TO METRIC UNITS OF MEASUREMENT

The following conversion factors adopted by the Bureau of Reclamation are those published by the American Society for Testing and Materials (ASTM Metric Practice Guide, January 1964) except that additional factors (*) commonly used in the Bureau have been added. Further discussion of definitions of quantities and units is given on pages 10-11 of the ASTM Metric Practice Guide.

The metric units and conversion factors adopted by the ASTM are based on the "International System of Units" (designated SI for Systeme International d'Unites), fixed by the International Committee for Weights and Measures; this system is also known as the Giorgi or MKSA (meter-kilogram (mass)-second-ampere) system. This system has been adopted by the International Organization for Standardization in ISO Recommendation R-31.

The metric technical unit of force is the kilogram-force; this is the force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 9.80665 m/sec/sec, the standard acceleration of free fall toward the earth's center for sea level at 45 deg latitude. The metric unit of force in SI units is the newton (N), which is defined as that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 1 m/sec/sec. These units must be distinguished from the (inconstant) local weight of a body having a mass of 1 kg; that is, the weight of a body is that force with which a body is attracted to the earth and is equal to the mass of a body multiplied by the acceleration due to gravity. However, because it is general practice to use "pound" rather than the technically correct term "pound-force," the term "kilogram" (or derived mass unit) has been used in this guide instead of "kilogram-force" in expressing the conversion factors for forces. The newton unit of force will find increasing use, and is essential in SI units.

Table I

QUANTITIES AND UNITS OF SPACE

| Multiply | By | To obtain |
|---|---|---|
| **LENGTH** | | |
| Mil | 25.4 (exactly) | Micron |
| Inches | 25.4 (exactly) | Millimeters |
| | 2.54 (exactly)* | Centimeters |
| Feet | 30.48 (exactly) | Centimeters |
| | 0.3048 (exactly)* | Meters |
| | 0.0003048 (exactly)* | Kilometers |
| Yards | 0.9144 (exactly) | Meters |
| Miles (statute) | 1,609.344 (exactly)* | Meters |
| | 1.609344 (exactly) | Kilometers |
| **AREA** | | |
| Square inches | 6.4516 (exactly) | Square centimeters |
| Square feet | 929.03* | Square centimeters |
| | 0.092903 | Square meters |
| Square yards | 0.836127 | Square meters |
| Acres | 0.40469* | Hectares |
| | 4,046.9* | Square meters |
| | 0.0040469* | Square kilometers |
| Square miles | 2.58999 | Square kilometers |
| **VOLUME** | | |
| Cubic inches | 16.3871 | Cubic centimeters |
| Cubic feet | 0.0283168 | Cubic meters |
| Cubic yards | 0.764555 | Cubic meters |
| **CAPACITY** | | |
| Fluid ounces (U.S.) | 29.5737 | Cubic centimeters |
| | 29.5729 | Milliliters |
| Liquid pints (U.S.) | 0.473179 | Cubic decimeters |
| | 0.473166 | Liters |
| Quarts (U.S.) | 946.358* | Cubic centimeters |
| | 0.946331* | Liters |
| Gallons (U.S.) | 3,785.43* | Cubic centimeters |
| | 3.78543 | Cubic decimeters |
| | 3.78533 | Liters |
| | 0.00378543* | Cubic meters |
| Gallons (U.K.) | 4.54609 | Cubic decimeters |
| | 4.54596 | Liters |
| Cubic feet | 28.3160 | Liters |
| Cubic yards | 764.55* | Liters |
| Acre-feet | 1,233.5* | Cubic meters |
| | 1,233,500* | Liters |

## Table II

## QUANTITIES AND UNITS OF MECHANICS

| Multiply | By | To obtain |
|---|---|---|
| | **MASS** | |
| Grains (1/7,000 lb) | 64.79891 (exactly) | Milligrams |
| Troy ounces (480 grains) | 31.1035 | Grams |
| Ounces (avdp) | 28.3495 | Grams |
| Pounds (avdp) | 0.45359237 (exactly) | Kilograms |
| Short tons (2,000 lb) | 907.185 | Kilograms |
| | 0.907185 | Metric tons |
| Long tons (2,240 lb) | 1,016.05 | Kilograms |
| | **FORCE/AREA** | |
| Pounds per square inch | 0.070307 | Kilograms per square centimeter |
| | 0.689476 | Newtons per square centimeter |
| Pounds per square foot | 4.88243 | Kilograms per square meter |
| | 47.8803 | Newtons per square meter |
| | **MASS/VOLUME (DENSITY)** | |
| Ounces per cubic inch | 1.72999 | Grams per cubic centimeter |
| Pounds per cubic foot | 16.0185 | Kilograms per cubic meter |
| | 0.0160185 | Grams per cubic centimeter |
| Tons (long) per cubic yard | 1.32894 | Grams per cubic centimeter |
| | **MASS/CAPACITY** | |
| Ounces per gallon (U.S.) | 7.4893 | Grams per liter |
| Ounces per gallon (U.K.) | 6.2362 | Grams per liter |
| Pounds per gallon (U.S.) | 119.829 | Grams per liter |
| Pounds per gallon (U.K.) | 99.779 | Grams per liter |
| | **BENDING MOMENT OR TORQUE** | |
| Inch-pounds | 0.011521 | Meter-kilograms |
| | 1.12985 x $10^6$ | Centimeter-dynes |
| Foot-pounds | 0.138255 | Meter-kilograms |
| | 1.35582 x $10^7$ | Centimeter-dynes |
| Foot-pounds per inch | 5.4431 | Centimeter-kilograms per centimeter |
| Ounce-inches | 72.008 | Gram-centimeters |
| | **VELOCITY** | |
| Feet per second | 30.48 (exactly) | Centimeters per second |
| | 0.3048 (exactly)* | Meters per second |
| Feet per year | 0.965873 x 10-6* | Centimeters per second |
| Miles per hour | 1.609344 (exactly) | Kilometers per hour |
| | 0.44704 (exactly) | Meters per second |
| | **ACCELERATION*** | |
| Feet per second$^2$ | 0.3048* | Meters per second$^2$ |
| | **FLOW** | |
| Cubic feet per second (second-feet) | 0.028317* | Cubic meters per second |
| Cubic feet per minute | 0.4719 | Liters per second |
| Gallons (U.S.) per minute | 0.06309 | Liters per second |
| | **FORCE*** | |
| Pounds | 0.453592* | Kilograms |
| | 4.4482* | Newtons |
| | 4.4482 x $10^{-5}$* | Dynes |

| Multiply | By | To obtain |
|---|---|---|
| | **WORK AND ENERGY*** | |
| British thermal units (Btu) | 0.252* | Kilogram calories |
| | 1,055.06 | Joules |
| Btu per pound | 2.326 (exactly) | Joules per gram |
| Foot-pounds | 1.35582* | Joules |
| | **POWER** | |
| Horsepower | 745.700 | Watts |
| Btu per hour | 0.293071 | Watts |
| Foot-pounds per second | 1.35582 | Watts |
| | **HEAT TRANSFER** | |
| Btu in./hr ft$^2$ deg F (k, thermal conductivity) | 1.442 | Milliwatts/cm deg C |
| | 0.1240 | Kg cal/hr m deg C |
| Btu ft/hr ft$^2$ deg F | 1.4880* | Kg cal m/hr m$^2$ deg C |
| Btu/hr ft$^2$ deg F (C, thermal conductance) | 0.568 | Milliwatts/cm$^2$ deg C |
| | 4.882 | Kg cal/hr m$^2$ deg C |
| Deg F hr ft$^2$/Btu (R, thermal resistance) | 1.761 | Deg C cm$^2$/milliwatt |
| Btu/lb deg F (c, heat capacity) | 4.1868 | J/g deg C |
| Btu/lb deg F | 1.000* | Cal/gram deg C |
| Ft$^2$/hr (thermal diffusivity) | 0.2581 | Cm$^2$/sec |
| | 0.09290* | M$^2$/hr |
| | **WATER VAPOR TRANSMISSION** | |
| Grains/hr ft$^2$ (water vapor transmission) | 16.7 | Grams/24 hr m$^2$ |
| Perms (permeance) | 0.659 | Metric perms |
| Perm-inches (permeability) | 1.67 | Metric perm-centimeters |

## Table III

## OTHER QUANTITIES AND UNITS

| Multiply | By | To obtain |
|---|---|---|
| Cubic feet per square foot per day (seepage) | 304.8* | Liters per square meter per day |
| Pound-seconds per square foot (viscosity) | 4.8824* | Kilogram second per square meter |
| Square feet per second (viscosity) | 0.092903* | Square meters per second |
| Fahrenheit degrees (change)* | 5/9 exactly | Celsius or Kelvin degrees (change)* |
| Volts per mil | 0.03937 | Kilovolts per millimeter |
| Lumens per square foot (foot-candles) | 10.764 | Lumens per square meter |
| Ohm-circular mils per foot | 0.001662 | Ohm-square millimeters per meter |
| Millicuries per cubic foot | 35.3147* | Millicuries per cubic meter |
| Milliamps per square foot | 10.7639* | Milliamps per square meter |
| Gallons per square yard | 4.527219* | Liters per square meter |
| Pounds per inch | 0.17858* | Kilograms per centimeter |

GPO 835-159

A simplified jet-flow regulating gate was developed by the Bureau of Reclamation for installation in small conduits of high head outlet works. The gate consists of an orifice to produce a contracting jet that springs clear of the gate slots, a movable gate leaf, a hydraulic cylinder and pump for moving the gate leaf, and an aerated downstream conduit. The regulating gate is simple to construct, cavitation-free at any gate opening, and the oil cylinder actuating mechanism is manually operated. One 10-in. (25.4-cm) regulating gate (10-in. orifice), designed for 250 ft (76.2 m) of head, was laboratory tested prior to being installed in a 12-in. (30.48-cm) bypass pipe in the outlet works at East Canyon Dam, Utah. Details of valve construction, operation, and coefficients of discharge and head loss are shown in the report. The maximum oil cylinder pressure required for gate movement is 185 psi (13.0 kg/sq cm) for a 250-ft (76.2-m) reservoir head. The discharge coefficient for the fully opened gate is 0.793, based on the area of the orifice and the total head in the pipeline (1.7 orifice diameters upstream from the orifice). The gate is excellent for control and discharge determination.

## ABSTRACT

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Bur Reclam Lab Rep Hyd-569, Hydraul Br, Feb 1969. Bureau of Reclamation, Denver, 8 p, 12 fig, 2 tab, 1 chart, 3 ref

DESCRIPTORS--/ gates/ *high pressure gates/ slide gates/ jets/ hydraulic structures/ outlet works/ *small structures/ control structures/ *manual control/ *discharge coefficients/ *flow control/ laboratory tests/ Utah/ hydraulic equipment/ calibrations/ gate position indicators/ head loss
IDENTIFIERS--/ East Canyon Dam, Utah/ Weber Basin Project, Utah/ jet-flow gates

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